

## *Proposed* ISO TC 184/SC4 STANDING DOCUMENT

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Technical Committee 184 for Industrial Automation Systems and Integration  
Subcommittee 4 for Industrial Data

**Guidelines for application protocol  
development using application modules  
Revision 0.3**

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## Foreword

The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

This standing document was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

ISO/TC 184/SC4 standards are prepared according to guidelines put forth in the following standing documents:

- Guidelines for application module development;
- Guidelines for application interpreted construct development;

NOTE 1 - The development of new AICs is deprecated due to the advent of application modules which are intended to be the next generation AICs.

- Guidelines for application interpreted model development;
- Guidelines for the development of application protocols using application modules;
- Guidelines for the development and approval of STEP application protocols;

NOTE 2 - The development of new APs using this process is deprecated due to the advent of application modules.

- Guidelines for the development of abstract test suites;
- Guidelines for the development of mapping tables;
- ISO/TC 184/SC4 organization handbook;
- Supplementary directives for the drafting and presentation of ISO 10303.

## Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application modules, application interpreted constructs, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303-1.

The purpose of this document is to provide guidelines for the development of application protocols (APs) using application modules (AMs). Application modules are the key component of the modularization of the initial STEP architecture. The modularization approach extends the application interpreted construct (AIC) concept of the initial STEP architecture through inclusion of the relevant portions of the AP's application reference model. The basis of the approach is understanding and harmonizing the requirements, both new and those documented in existing APs, grouping the requirements into reuseable modules, documenting the modules, and using the modules in the development of an application protocol. With much of the content of the initial STEP architecture AP now documented in AMs, the role of the AP is to select and constrain a set of the more generic AMs to satisfy information requirements in a particular application context.

The development of an application protocol modularization strategy was driven by several requirements from different sources:

- to reduce the high cost of developing an application protocol;
- to ensure the ability to implement a combination of subsets of multiple APs or to extend existing APs to meet a business need;
- to ensure the ability to reuse application software developed to support one AP in the development of an implementation of another AP with the same, or similar, requirements;
- to avoid the duplication and repeated documentation of the same requirements in different application protocols leading to potentially different solutions for the same requirements; and
- to ensure the ability to reuse data generated by an implementation of one or more APs by an implementation of one or more different APs.

The expected audience for this document includes developers of STEP application modules and application protocols as well as users of STEP application protocols who are interested in a more in-depth understanding of the origins of the structure of application protocols. This document is an adaptation of the guidance found in *Guidelines for the development and approval of STEP application protocols*, *Guidelines for application interpreted model development*, and *Guidelines for application interpreted construct development*.

This document describes the proposed content of an application protocol and guidelines for development of the content of the application protocol based on the use of application modules..

# Guidelines for application protocol development using application modules

## 1 Scope

This SC4 standing document specifies guidelines for the development and documentation of ISO 10303 application protocols using application modules.

The following are within scope of this standing document:

- description of the content of an application protocol using application modules;
- guidelines for developing the content of an application protocol developed using application modules.

The following are outside the scope of this standing document:

- guidelines for developing the content of an application module including detailed guidance on the development of scope, information requirements, mapping tables and module interpreted models;
- specification of presentation information for the documentation of an ISO 10303 application protocol.

## 2 Normative references

The following standing documents and standards contain provisions which, through reference in this text, constitute provisions of this standing document. At the time of publication, the editions indicated were valid. All standing documents and standards are subject to revision, and parties to agreements based on this standing document are encouraged to investigate the possibility of applying the most recent editions of the standing documents and standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/TC 184/SC4 N534:1997, *Guidelines for application interpreted construct development*.

ISO/TC 184/SC4 N535:1997, *Guidelines for the development and approval of STEP application protocols*.

ISO/TC 184/SC4 Nxxx:1997, *Guidelines for the development of application modules*.

ISO/TC 184/SC4 N533:1997, *Guidelines for the development of mapping tables*.



ISO/TC 184/SC4 N537:1997, *Supplementary directives for the drafting and presentation of ISO 10303*.

ISO 10303-11:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: Language reference manual*.

## 3 Definitions and abbreviations

### 3.1 Terms defined in ISO 10303-1

This SC4 standing document makes use of the following terms defined in ISO 10303-1.

**3.1.1 application:** a group of one or more processes creating or using product data.

**3.1.2 application activity model (AAM):** a model that describes an application in terms of its processes and information flows.

**3.1.3 application context:** the environment in which the integrated resources are interpreted to support the use of product data in a specific application.

**3.1.4 application interpreted model (AIM):** an information model that uses the integrated resources necessary to satisfy the information requirements and constraints of an application reference model, within an application protocol.

**3.1.5 application object:** an atomic element of an application reference model that defines a unique concept of the application and contains attributes specifying the data elements of the object.

**3.1.6 application protocol (AP):** a part of this International Standard that specifies an application interpreted model satisfying the scope and information requirements for a specific application.

NOTE - This definition differs from the definition used in open system interconnection (OSI) standards. However, since this International Standard is not intended to be used directly with OSI communications, no confusion should arise.

**3.1.7 application reference model (ARM):** an information model that describes the information requirements and constraints of a specific application context.

**3.1.8 conformance class:** a subset of an application protocol for which conformance may be claimed.

**3.1.9 data:** a representation of information in a formal manner suitable for communication, interpretation, or processing by human beings or computers.

**3.1.10 implementation method:** a part of this International Standard that specifies a technique used by computer systems to exchange product data that is described using the EXPRESS data specification language [ISO 10303-11].

**3.1.11 interpretation:** the process of adapting a resource construct from the integrated resources to satisfy a requirement of an application protocol. This may involve the addition of restrictions on attributes, the addition of constraints, the addition of relationships among resource constructs.

**3.1.12 product data:** a representation of information about a product in a formal manner suitable for communication, interpretation, or processing by human beings or by computers.

**3.1.13 resource construct:** a collection of EXPRESS entities, types, functions, rules and references that together define a valid description of an aspect of product data.

**3.1.14 unit of functionality (UoF):** a collection of application objects and their relationships that defines one or more concepts within the application context such that removal of any component would render the concepts incomplete or ambiguous.

## 3.2 Terms defined in ISO 10303-202

This SC4 standing document makes use of the following terms defined in ISO 10303-202.

**3.2.1 application interpreted construct (AIC):** a logical grouping of interpreted constructs that supports a specific function for the usage of product data across multiple application contexts.

## 3.3 Other definitions

For the purposes of this SC4 standing document the following definitions apply.

**3.3.1 application module (AM):** a reusable collection of scope statement, information requirements, mappings and application interpreted model that supports a specific usage of product data across multiple application contexts.

**3.3.2 Industrial ARM:** an information model that describes the information requirements and constraints of a specific application context using specific industrial terminology.

## 3.4 Abbreviations

For the purposes of this SC4 standing document, the following abbreviations apply.

AAM application activity model

AIC application interpreted construct

AIM application interpreted model

AM application module

AP application protocol

ARM application reference model

CC conformance class

IR integrated resource

UoF unit of functionality

## 4 Application protocol content

This clause provides an overview of the contents of an application protocol that has been developed using application modules. The contents for an application protocol are given in figure 1 and are explained in the subsequent subclauses. The four major components of an AP are: 1) the scope and functional requirements; 2) industry specific terminology and definitions; 3) the application interpreted model that specifies the required use of the common resources, and 4) conformance requirements.

Each application protocol shall have an associated abstract test suite (ATS) that makes use of the ATSs associated with each application module.

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**Figure 1 - Contents of an application protocol**

An AP starts with the definition of the scope of the AP. The industry specific information requirements of the AP, including terminology, are documented in clause 4 of the AP.

Detailed requirements for documenting an AP, including any required text, are provided in the *Supplementary directives for the drafting and presentation of ISO 10303*.

The Introduction for the AP shall provide an overview of the technical content. The Introduction shall explain the relationships between the AMs that comprise the AP.

## 4.1 Scope

Clause 1 of an AP shall define the domain of the AP and summarize the fundamental concepts and assumptions of the scope, the functionality of the AP, and the types of information that are accommodated by the AP. A description of the functionality and information that are specifically outside the scope of the application shall be defined to clarify the domain of the AP.

This clause shall define the following characteristics of the scope of the application protocol:

- type of information;
- life cycle stages supported;
- uses of the information, e.g., functional processes, supported;
- discipline views supported;
- exclusions from scope for the purpose of clarification.

The scope of an AP may be the union of the scopes of all the application modules that comprise the AP.

## 4.2 Normative references

All normative references shall be listed in clause 2 of an AP. The minimal required set of normative references are:

- ISO 10303-1 *Industrial automation systems and integration - Product data representation and exchange - Part 1: Overview and fundamental principles.*
- ISO 10303-11 *Industrial automation systems and integration - Product data representation and exchange - Part 11: Description methods: The EXPRESS language reference manual.*
- ISO 10303-31 *Industrial automation systems and integration - Product data representation and exchange - Part 31: Conformance testing methodology and framework: General concepts.*

## 4.3 Definitions and abbreviations

Clause 3 of an AP shall include definitions of all concepts necessary to understand the Introduction, Scope, and Information requirements clauses. This clause may include concepts that are defined further in the Information requirements clause. The concept definitions provided in this clause shall be consistent with the complete definitions provided in the Information requirements clause.

This clause shall contain at least three subclauses: list of terms defined in ISO 10303-1 and used in the AP, terms defined in the AP, and abbreviations and symbols used in the AP. This clause shall not include the definitions of objects defined in the application interpreted model. This clause shall list the terms defined in other ISO standards, including AMs, that are necessary for understanding the AP.

## **4.4 Information requirements**

Clause 4 of an AP shall describe the industry specific terminology and definitions and information requirements of the AP. The first paragraphs of this clause provide a high level description of the information requirements that are supported by the AP and a summary of the structure used to partition the information requirements. This clause may include a description of the types of information supported by the AP, any restrictions on the information supported, and the supported uses of the defined information. This clause shall provide all additional information on the fundamental concepts and assumptions (initially introduced in clauses 1 and 3) which is necessary for complete understanding of the information requirements and the scope boundaries.

This clause shall include a description the fundamental concepts and UoFs of the AP and all AMs used by the AP.

This clause shall include subclauses for units of functionality, industry specific terminology and application constraints.

### **4.4.1 Units of functionality**

Clause 4.1 of an AP shall specify a list of the UoFs defined in the AMs used in the AP. This list shall include a reference to the AM where the UoF is defined.

### **4.4.2 Industry specific terminology**

Clause 4.2 of an AP shall include the industry specific requirements, terminology and definitions defined in the AP. This clause shall also describe the correspondence between the industry specific terminology and the terminology defined in the AMs comprising the AP.

### **4.4.3 Application constraints between modules**

Clause 4.3 of an AP shall specify the necessary constraints among application required for the integrity and validity of the relationships between the AMs used by the AP.

## **4.5 Application interpreted model short form**

Clause 5 of an AP shall specify the application interpreted model. The AIM shall be defined using the EXPRESS language and is constructed from the common resources using the EXPRESS interfacing mechanism (USE FROM) defined in ISO 10303-11.

The AIM EXPRESS short listing shall consist of USE FROM statements that select common resource constructs AP specific declarations. The declarations include TYPE and ENTITY declarations that create subtypes of resource entities for concept completion, and any necessary RULES, FUNCTIONS, and PROCEDURES that are required to satisfy the information requirements. Any declarations of types, entities, rules, functions, and procedures specific to the AP are fully documented in the AIM EXPRESS short listing. Textual descriptions are included in clause 5 for the specification of all new EXPRESS constructs defined in the AP.

## 4.6 Annexes

### A Implementation method specific requirements (normative)

This annex shall contain additional requirements for the specified implementation methods. For example, an AP to be used with Part 21, requires the schema name of the AP to be specified in the header section of a file. The required schema name for the header section would be specified in Annex C of the AP.

The implementation method specific requirements shall be in addition to those listed in the AP's conformance requirements clause. This annex may specify the meaning of values not given in the normative clauses. If no implementation specific requirements are specified, this fact shall be stated in this annex.

### B Protocol Implementation Conformance Statement (PICS) proforma (normative)

This annex shall contain the PICS proforma that explicitly defines the implementation flexibility, if any, allowed by the application module specification. The PICS proforma is given in the form of a questionnaire to be completed by the supplier or implementor of an implementation of the AP before it undergoes conformance testing. The PICS proforma shall cover all optional functions, preparation procedures for the conformance assessment process, parameters, and other capabilities identified in the AP. The completed questionnaire shall be used by conformance testing laboratories for abstract test case selection and parameterization.

### C Information object registration (normative)

This annex shall specify the information object identifiers for the application protocol. This shall include identifiers for the AP document and for the AIM schema

### D Application activity model (optional and informative)

This annex, if provided, shall contain the application activity model (AAM) that provides a representation of the application context of the AP and of the activities which use product data in the

application context. AAMs are mechanisms for scoping the information requirements for individual APs and for planning the development of nested APs. The AAM shall be represented in IDEF0 [4].

The AAM includes the definition of the inputs, controls, outputs, and some of the mechanisms of those activities. Only those mechanisms that are organization and enterprise independent shall be included.

The first paragraphs of this annex shall explain the context of the AAM and summarize the assertions on which the AAM is based. The definitions for all activities and information flows in the AAM shall be provided in annex D.1, and the IDEF0 diagrams shall be provided in annex D.2.

#### **E Industrial application reference model (optional and informative)**

This annex, if provided, shall contain the industrial application reference model (Industrial ARM) in industry specific terminology that has correspondence to the formal model of the information requirements and constraints of the application module as defined by the ARMs found in the AMs comprising the AP. The industrial application reference model may apply industry specific names to the application objects and relationships defined in an AM ARM but may not change the structure or relationships between those objects.

The first paragraphs of this annex shall summarize the scope of the Industrial ARM. The Industrial ARM uses industry-specific terminology and rules familiar to an expert from the application context. The Industrial ARM shall be documented by use of EXPRESS. The Industrial ARM, together with the AP scope statement and the ARMs of the AMs comprising the AP not requiring industry specific terminology, shall be sufficient for a person familiar with the application to understand the AP domain.

#### **F AIM EXPRESS listing (informative)**

This annex shall contain a disk with the entire AIM EXPRESS short listing without comments.

#### **G Application protocol implementation and usage guide (optional and informative)**

This annex, if provided, contains informative guidance on implementing and using the AP. This annex provides guidance to two different audiences, i.e., implementors and end users of AP compliant implementations. Example information descriptions that are supported by the AP and the corresponding AP exchange files may be included in this annex. If exchange files are included in this annex, the annex should explain the primary data structures and the logic and meaning of the values used in the exchange file.

#### **H Technical discussions (optional and informative)**

This annex, if provided, contains a summary of relevant technical discussions and the resolution of issues raised during the development of the AP. This annex provides background information for potential users of the AP and for developers of similar or related APs. The material given should not cast doubt or self justify. Only material which supports the normative text shall be given.

#### **I Bibliography (informative)**

This annex lists all informative references relevant to the AP. At a minimum, it shall contain references to the *Supplementary directives for the drafting and presentation of ISO 10303*.

## 5 Specification of application protocol content

This clause specifies the requirements for developing an AP. An AP shall be developed and reviewed incrementally as components of the AP documentation are completed. The major objective of the incremental development is for AP developers to understand and select the relevant AMs and to determine domains where new AMs are required. A review of the AP's scope and information requirements, prior to selecting or defining new AMs, allows international consensus on the detailed requirements to be developed. It also allows identification of requirements common with other applications for the purpose of AM integration, refinement and planning.

### 5.1 Scope development

The first phase of developing an AP is the definition of its scope and information requirements. Definition of the scope and information requirements begins with the formulation of a statement of the application protocol functional requirements. This statement shall define the type(s) of information, the life cycle stages supported, the data application(s), and the use of the data within the application(s) targeted for the AP. The detailed scoping and information requirements definition shall proceed from this statement.

The scope and requirements identify the primary concepts and relationships to be supported by the AP. The AP's scope and information requirements shall be carefully defined and documented. The AP scope statement shall include a summary of the type(s) of information, the application processes, the types of data, and the discipline views of the data that are within scope. For clarification, the scope statement may also identify the type(s) of information, the type(s) of products, the application processes, the types of product data, and the discipline views of the data that are outside of the scope.

NOTE - The scope of an AP is often refined by developing an activity model or by referencing one or more existing AP's activity models. Activities, inputs, controls, outputs, and mechanisms should be examined, and a determination made as to whether they are in scope for the AP. The inclusion of mechanisms, e.g., resources and tools, in an AP should be carefully analyzed. Only those mechanisms that are organization and enterprise independent should be included.

### 5.2 Information requirements specification

When the detailed scope and functional requirements have been defined, the information domain of the AP shall be developed by first reviewing existing application modules for use by the AP, determining voids in AM coverage of the scope of the AP. Next an application reference model (ARM) covering the voids is defined. If required, an industrial application reference model (Industrial ARM) is also defined where changes in existing AM ARM terminology are required. The ARM shall guide new AM development and the Industrial ARM shall document existing AM requirements in industry terminology. The ARM shall be documented using EXPRESS and shall include an EXPRESS-G presentation. The ARM and Industrial ARM shall describe fully the data needs of the application protocol, using the potentially harmonized terminology



of the application domain. The new ARM to be created will be reviewed and a determination made as to the scopes of a set of application modules to be developed based on the ARM. The ARM shall be partitioned into UoFs and divided into a set of AMs. Development of the AMs shall follow the process and requirements found in *Application module development guidelines*.

An ARM shall be sufficiently detailed so that the selection and interpretation of the common resources can be done accurately. The ARM documents the required data and relationships. The graphical presentation of the ARM, i.e., EXPRESS-G, aids the understanding and review of the information requirements and definitions. The ARM diagrams shall be at a detail level sufficient to present the requirements in a manner that it is understandable to an application domain expert. The information requirements shall be modelled only to the level necessary to convey the information that is important from the application experts' point of view.

An Industrial ARM will be a representation of the ARM using Industrial Terminology. An Industrial ARM will not modify the required data or relationships documented in the ARM other than by renaming those data and relationships.

A UoF is a mechanism for modularizing the scope of an industry domain into manageable constructs is to define units of functionality. A UoF is a collection of application objects and relationship attributes that conveys one or more well-defined concepts within the context of an ARM. A UoF may result in one or more AM's and an AM may include or use more than one UoF. A UoF usually supports an application function or process. UoFs are used to organize and summarize the functionality of the ARM. For example, if a geometric modelling application has a requirement for wireframe geometry, then a UoF may be defined which provides a grouping of those application objects in the ARM which are intended to support geometric modelling using wireframe geometry.

When two or more AMs have equivalent UoFs or common information requirements, a new AM shall be created, the same interpretation of the integrated resources shall be used in the new AM, and the new AM shall be used by the AM's with common requirements. HEREHERE

### **5.2.1 Industrial ARM, ARM and information requirements documentation**

Clause 4 of the AP shall include a high level description of the information requirements, a summary of the structure used to define the partition of the information requirements defined by the AP, and subclauses for specifying UoFs, application objects, and application assertions. The description of the information requirements shall be sufficient to prepare the reader for the material in the three subclauses.

The grouping of UoF's defined in the AP into logical sets that aid in the understanding of the information domain is recommended. The logic of these groups of UoFs shall be included in 4.1.

The industry specific information requirements, application objects, and application assertions shall be defined in prose. The elements listed within these subclauses shall be organized by UoFs or to match the structure of the ARM found in the AMs comprising the AP. UoFs, application objects and application assertions shall have unique names, i.e., no application elements shall share the same name. The correspondence of the industry specific terminology to the AM terminology shall be documented in prose.

The documentation for an AP's Industrial ARM and information requirements includes the following components.

#### 1. Industrial ARM

The Industrial ARM shall be included in annex C of the AP. The Industrial ARM uses the terminology of the application and shall be documented with EXPRESS.

#### 2. units of functionality

Units of functionality shall be defined in 4.1 of the AP. This subclause provides a list of the UoFs used in the AP or defined in the AP. For industry specific UoFs defined in the AP, an industry specific description of the functions that each UoF supports, the corresponding application module UoF and the list of industry specific application objects included in the UoF is specified.

#### 3. application objects

The application objects shall be defined in 4.2 of the AP and are derived from the Industrial ARM. Each object which exists in the Industrial ARM shall be defined. Its correspondence to an AM application object shall be documented.

#### 4. relationship attributes

The relationship attributes shall be defined in 4.3 of the AP and are derived from the Industrial ARM. These assertions define relationships among application objects, the cardinality of the relationships, and the rules constraining one or more relationships among application objects required to maintain their integrity. Usage constraints, and relationships among valid interdependent values within the application domain are specified within the assertion that the AP project team deems most appropriate. These constraints may or may not be possible to be modelled in any graphical representation of requirements. The correspondence to an AM relationship attribute shall be documented.

EXAMPLE XX - A constraint may be necessary in an enterprise payroll application module to ensure the validity of the total salary budget. Such a constraint may be specified in the assertion between an employee object and a salary object. This constraint may be stated as, "The sum of the salaries of all employees of a department may not exceed the budget of the department."

### 5.2.2 EXPRESS Industrial ARM documentation

The Industrial ARM EXPRESS application object definitions and relationship attributes shall be specified as follows:

- Each entity shall be stated in the application object definitions.
- Each attribute whose data type is either a base data type or a defined data type which is a SELECT data type with a select list that does not contain entity types or, recursively, other SELECT types with